

# Using Assistive Technology Adaptations to Include Students with Learning Disabilities in Cooperative Learning Activities

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## Abstract

Cooperative learning (CL) is a common instructional arrangement that is used by classroom teachers to foster academic achievement and social acceptance of students with and without learning disabilities. Cooperative learning is appealing to classroom teachers because it can provide an opportunity for more instruction and feedback by peers than can be provided by teachers to individual students who require extra assistance. Recent studies suggest that students with LD may need adaptations during cooperative learning activities. The use of assistive technology adaptations may be necessary to help some students with LD compensate for their specific learning difficulties so that they can engage more readily in cooperative learning activities. A process for integrating technology adaptations into cooperative learning activities is discussed in terms of three components: selecting adaptations, monitoring the use of the adaptations during cooperative learning activities, and evaluating the adaptations' effectiveness. The article concludes with comments regarding barriers to and support systems for technology integration, technology and effective instructional practices, and the need to consider technology adaptations for students who have learning disabilities.

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Cooperative learning is a peer-mediated instructional arrangement that is used for fostering academic achievement and social acceptance of students with and without learning disabilities (LD; Friend & Bursuck, 1996; Johnson, Johnson, Warring, & Maruyama, 1986; Rich, 1993; Sharan, 1980). During cooperative learning activities, students assume responsibilities related to assigned roles (e.g., writer, reader), complete activities that teach and reinforce academic skills, and apply interpersonal skills in a group setting (Johnson, Johnson, & Holubec, 1994). Students work in small, heterogeneous groups to accomplish tasks by modeling correct academic responses, practicing skills and providing feedback, sharing in reinforcement contingencies, and engaging in social interactions (Lloyd, Crowley, Kohler, & Strain, 1988). Cooperative learning is appealing because peers can provide instruc-

tion and feedback more often than teachers can provide individual assistance to students who require it (Lloyd et al., 1988; O'Connor & Jenkins, 1994).

The rationale for using cooperative learning to foster academic achievement and social acceptance is persuasive; however, studies of students with learning disabilities working in cooperative learning groups have produced mixed results (Lloyd et al., 1988; O'Connor & Jenkins, 1994). For instance, cooperative learning conditions as compared to no-treatment and individualized instruction conditions have produced social benefits (i.e., less social rejection) for students with disabilities (Johnson et al., 1986). Academically, however, students with learning difficulties have not fared consistently better in cooperative learning conditions than in individualized learning conditions (Cosden, Pearl, & Bryan, 1985). Moreover, researchers have posited that students with learn-

ing disabilities may need instructional adaptations during cooperative learning activities (e.g., O'Connor & Jenkins, 1994) because they do not possess the skills (e.g., academic, collaborative) needed to successfully accomplish the tasks inherent in cooperative learning activities.

Instructional adaptations consist of changes or modifications to teaching procedures, curricula, management, materials and technology, and the physical environment to facilitate learning (Rivera & Smith, 1997). Instructional adaptations are an integral component of special education and assist students in compensating for the challenges associated with disabilities (McGregor & Pachuski, 1996). In the field of learning disabilities, adaptations (e.g., alternative responding modes, modified instructional materials) have been widely used to help students compensate for specific learning difficulties associated with read-

ing, writing, mathematics, reasoning, listening, and speaking. Moreover, in the last decade, advances in computer-based technology, and the recognition of the instructional-accessibility capabilities of assistive technologies, have prompted an array of adaptation solutions for students with learning disabilities.

Specifically, assistive technology adaptations can be used by individuals with disabilities to circumvent disability-related barriers (Garner & Campbell, 1987; McGregor & Pachuski, 1996) and may be necessary to help some students with LD compensate for their specific learning difficulties (MacArthur & Haynes, 1995), so that they can engage more readily in cooperative learning. An *assistive technology device* (e.g., pencil grip, alternative keyboard, speech synthesizer, tape recorder, word prediction software, electronic spell checkers, talking word processing programs) is defined as "any item, piece of equipment, or product system, whether acquired commercially, modified, or customized that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (Technology-Related Assistance for Individuals with Disabilities Act, 1988, p.102, Stat., 1046; see Bryant and Seay's article in this series). Thus, assistive technology devices can be considered instructional adaptations when they are used by individuals with learning disabilities (or any disability) to "improve functional capabilities" in classroom settings.

As specified in federal legislation and policy statements (e.g., P.L. 94-142, P.L. 101-476, P.L. 105-17, Section 504; Schrag, 1990), school district personnel must ensure that assistive technology devices and services are available as a special education service, supplementary aide, related service, modification, or accommodation if they are deemed necessary for guaranteeing a free, appropriate public education (Bowser & Reed, 1995; Male, 1997; Schrag, 1990). Child study teams may recommend AT devices to help stu-

dents with LD compensate for their specific disabilities and to meet the instructional demands of their classroom. Moreover, through the process of selecting appropriate instructional adaptations, students with learning disabilities who are already receiving special education services may be identified by their teachers and technology specialists as in need of AT devices to foster accessibility to the curriculum.

Assistive technology devices can be used by elementary, secondary, and postsecondary students with LD and promote academic skills (Behrmann, 1994; Bryant, Rivera, & Warde, 1993; Church & Glennen, 1992; Day & Edwards, 1996; MacArthur, 1993), independence, self-worth, and productivity (C. Abete, personal communication, February 12, 1996; Barton & Fuhrmann, 1994; Brown, 1989; Raskind & Shaw, 1996). Although limited in number, emerging research findings validate the benefits of assistive technology devices/adaptations in reading (Olson, Foltz, & Wise, 1986; Roth & Beck, 1987; van Daal & Reitsma, 1990), writing (Cosden, Goldman, & Hine, 1990; MacArthur, Schwartz, & Graham, 1991; Wetzel, 1993), math facts (Chiang, 1986; Kosciński & Gast, 1993), and study skills (Anderson-Inman, Knox-Quinn, & Horney, 1996; Higgins, Boone, & Lovitt, 1996).

In the last decade, educators have seen a significant increase in the availability of AT devices that can enable students with learning disabilities to participate more fully in instructional activities (Bryant & Rivera, 1995). Through the use of assistive technology adaptations, students with LD have the potential to access instructional activities, such as cooperative learning, to the same degree as their peers and to circumvent disability-related limitations (e.g., reading comprehension difficulties, handwriting problems, difficulties with spelling, problems remembering basic arithmetic facts; Lewis, 1993; MacArthur et al., 1991). However, the benefits of assistive technology adaptations

cannot be fully realized unless teachers employ a systematic process for integrating the adaptations in classroom instruction. Technology integration facilitates teaching and learning (Edyburn, 1992; Moersch, 1995; Panyan, Hummel, & Jackson, 1988; Sheingold, 1991); however, teachers must select technology adaptations appropriately, and monitor and evaluate the use of these adaptations in classroom activities to determine their educational benefit for students with LD.

The purpose of this article was to discuss a process for incorporating assistive technology adaptations into cooperative learning activities. Cooperative learning was chosen as the instructional focus for technology integration because it is a popular instructional arrangement used by both special and general educators to promote the academic and social success of students with learning disabilities. First, a description of cooperative learning is presented, including information about tasks and responsibilities that may be problematic for students with specific learning disabilities. Next, including students with LD more successfully in cooperative learning activities via the integration of assistive technology adaptations is discussed. Third, final thoughts about barriers to and teacher support systems for technology integration are presented.

## An Overview of Cooperative Learning

Although it is beyond the scope of this article to present a comprehensive discussion of cooperative learning (see Johnson et al., 1994, for additional information), a brief explanation is necessary as background information. The explanation includes a discussion of the three phases of cooperative learning. A discussion of barriers to the successful completion of cooperative learning activities by students with learning disabilities concludes this section.

## Phases

Cooperative learning can be conceptualized by an organizational framework consisting of three phases: planning, implementation, and evaluation. Overviews of each phase follow.

### Planning

The planning phase consists of six components: academic and collaborative instructional objectives, groups, roles, activities, and elements (Johnson & Johnson, 1986; Sharan, 1980; Slavin, Madden, & Leavey, 1984). Academic and collaborative objectives are the basis for cooperative learning instruction and are derived from a variety of resources, such as curriculum guides, textbooks, and assessments. In particular, teachers should examine students' Individualized Education Programs (IEPs) to determine if AT devices have been recommended by the child study team (Bowser & Reed, 1995; Bragman, 1987).

Cooperative learning groups usually consist of students with heterogeneous ability levels. Such group composition promotes diverse discussion perspectives and diverse approaches to activities planned for the instructional objectives (Johnson, Johnson, Holubec, & Roy, 1984).

Interdependent roles (e.g., *writer*—listen to group, identify important points, record information accurately and quickly; *spokesperson*—read writer's notes, summarize group's work, share with large group; *timekeeper*—monitor time) are assigned to increase individual student involvement and to create situations wherein group members are dependent on one another to complete the activity (Johnson & Johnson, 1986). Roles include responsibilities (e.g., recording the group's responses, speaking to the class on behalf of the group, monitoring instructional time, evaluating written answers) that enable group members to accomplish tasks interdependently; thus, students are held accountable to the group for fulfilling their responsibilities.

Johnson, Johnson, and Holubec (1991) identified four structural elements of cooperative learning activities: positive interdependence, individual accountability, interpersonal and small-group skills, and group processing. *Positive interdependence* means that the success of the group depends on the success of each group member. Students are expected to learn the assignment, help their teammates learn the material, and complete the assignments (Johnson et al., 1991).

*Individual accountability* is evident when students recognize that their performance affects the group's success; that is, all individuals are accountable for their actions as they relate to task completion (Johnson et al., 1991). Furthermore, students' mastery of the lesson's content is measured individually; thus, they help the group earn a grade and they are graded individually for their efforts.

*Collaborative and interpersonal skills* are an important element of cooperative learning because they represent the ways in which individuals interact and work collectively. Decision making, trust building, communication, leadership, and conflict management are important group skills (Johnson & Johnson, 1986). Additionally, interpersonal skills such as accepting and giving criticism and praise, listening, turn taking, sharing, compromising, and exhibiting responsible behavior are necessary for successful group interactions.

Finally, *group processing* is conducted following the cooperative learning activity, when students examine their group behavior by completing a self-evaluation sheet and discussing their interactions. Specific behaviors that need improvement can be targeted for the next cooperative learning activity.

### Implementation

Research has shown that teacher supervision, corrective feedback, and instruction are particularly important for students demonstrating learning difficulties (Brophy & Good, 1986). The

implementation phase consists of teachers' monitoring and intervening as students work in their cooperative learning groups and is initiated once time has been invested in initial instruction in the academic and collaborative objectives and individual roles. The monitoring and intervening component involves the following: (a) teachers monitor students' behavior, (b) they provide task assistance, and (c) teachers intervene to teach interpersonal and small group skills. Additional directions, modeling, asking of questions to redirect students' thinking, and reteaching of vocabulary may be necessary to help students proceed with the task.

### Evaluation

The evaluation phase is multidimensional and consists of group assessment of academic and collaborative instructional objectives and individual assessment of academic performance. Group performance can be assessed by assigning group grades, recording occurrences of collaborative skills, and collecting anecdotal notes about group behaviors (Johnson et al., 1984). Moreover, group efforts and behaviors can be evaluated by the students during the group processing element of cooperative learning. Individual performance can be monitored via quizzes or teacher conferences.

## Barriers to Cooperative Learning

Students with LD may encounter barriers that impede their success with cooperative learning activities; when such barriers occur, assistive technology adaptations may be the appropriate solution. Specifically, students may lack the requisite skills (e.g., reading, writing, spelling, handwriting, memory, motor, mathematics) needed to meet the demands of cooperative learning (Male, 1997; O'Connor & Jenkins, 1994).



In particular, students must work as contributing members and not rely solely on their peers for solving problems and completing tasks. The responsibility of contributing to the completion of a group assignment may be particularly burdensome for students with LD whose disabilities hinder successful academic interactions. The assigned role responsibilities may exceed student capabilities. For instance, students may lack spelling and organizational skills, have difficulty summarizing and recording the key points of group discussions, or lack the fine-motor skills called for in handwriting. Reading difficulties may interfere with gaining information from textbooks, resource materials, and worksheets; and students may lack math problem-solving or computational skills. Thus, a close examination of the responsibilities of each role may reveal skills that students lack and help teachers anticipate role-related difficulties.

Students with academic problems may be able to function effectively in cooperative learning situations because other group members can explain information to and encourage those who may be struggling with the activity. However, Dansereau (1988) noted that individual learning characteristics (e.g., verbal ability, lack of skills) of group members may hinder the academic benefit derived from cooperative learning activities. Thus, some students with LD may require adaptations to help them master the goals, carry out role responsibilities, work successfully in groups, and be contributing members. For these students, AT adaptations could be helpful in circumventing disability-related barriers and promoting access to the activity. The challenge for teachers is to plan the cooperative learning activity, determine possible barriers for individual students with learning disabilities, select appropriate AT devices, monitor student use during the implementation phase, and evaluate the effectiveness of the device. In the following section, a process for integrat-

ing assistive technology adaptations into cooperative learning activities is described.

### **Integrating Assistive Technology Adaptations Into Cooperative Learning Activities**

The integration of technology into classroom instruction is recognized as an important element of effective instruction and involves the perception that technology tools can be used to solve a variety of "authentic" problems (Edyburn, 1992; Moersch, cited in Male, 1997). Certainly, adapting instruction to meet the needs of students with learning disabilities is an "authentic" problem faced by educators on a daily basis (Schumm & Vaughn, 1991); assistive technology adaptations can be used to address some of the learning difficulties. However, technology adaptations must be aligned with instructional arrangements and students' particular learning needs (Edyburn, 1992).

A process for integrating technology (in this case, technology adaptations) into cooperative learning activities is discussed in terms of three components: selecting devices or adaptations, monitoring the use of the devices during cooperative learning activities, and evaluating their effectiveness. Questions to consider when integrating assistive technology adaptations into cooperative learning activities, are provided in Figure 1.

### **Selecting Assistive Technology Adaptations**

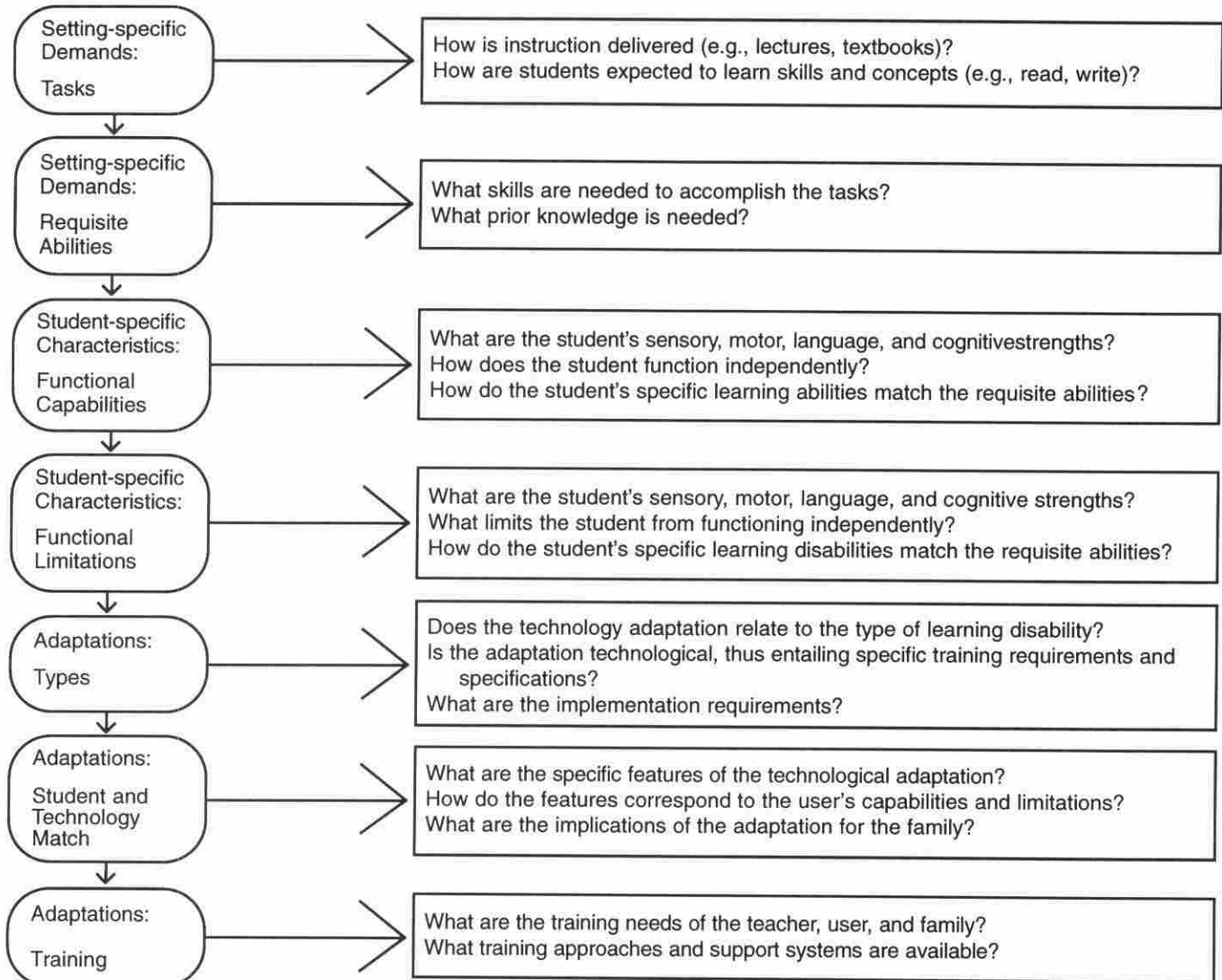
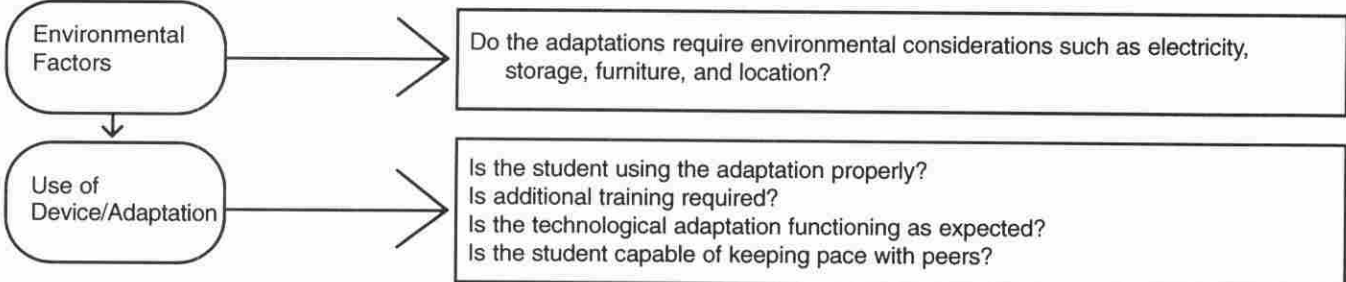
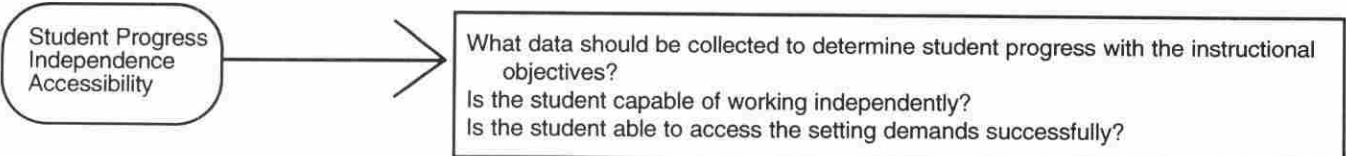
The process of integrating technology adaptations into classroom instruction begins with the technology team. Team members could include the user, family members, teachers, job coaches, technology specialists, administrators, and funding specialists (Carney & Dix, 1992; Male, 1997). The

role of the team is individualized according to the needs of the user and teachers; however, foremost must be the development of a technology integration action plan (Carney & Dix, 1992; Male, 1997). The plan should include specific strategies for ensuring that technology adaptations are integrated into instruction and that the assessment, action (e.g., activities, timelines, person responsible), and review phases are specified (Carney & Dix, 1992; Male, 1997).

Selecting assistive technology adaptations represents the first step in the process of integrating assistive technology adaptations into cooperative learning activities. As teachers design cooperative learning lessons (i.e., select objectives, identify roles and groups, and develop the activity) and identify potential barriers for students with LD, assistive technology devices may be deemed the appropriate instructional adaptations. Technology team members can determine the devices that best match students' individual learning characteristics and that assist students in fulfilling educational program objectives by considering the setting demands (i.e., tasks and requisite abilities), individual characteristics (i.e., capabilities and disability-related limitations), and adaptations needed for participation in group activities (Bryant & Rivera, 1995).

### **Setting-Specific Demands**

More than a decade of research (e.g., Christenson, Ysseldyke, & Thurlow, 1989; Deshler & Schumaker, 1986; Riegel, 1988; Rieth & Evertson, 1988; Schumaker & Deshler, 1984) has documented the importance of examining the setting demands of learning environments. Setting demands include the curriculum, ways in which information is delivered and received, how students demonstrate their knowledge and understanding of skills and concepts (Rivera & Smith, 1997), tasks students must address, and the requisite abilities for performing the tasks. For example, listening, identifying main

**SELECTION****MONITORING****EVALUATION****FIGURE 1.** Assistive technology adaptation—integration questions.

points, and taking notes are tasks associated with instruction that is delivered in a lecture format. Students must possess the requisite abilities of demonstrating selective attention, recognizing words that signal main points, and possessing efficient and effective note-taking strategies to accomplish these tasks.

**Tasks.** In the classroom setting, students are expected to perform numerous tasks as part of the learning process. For example, they may be expected to comprehend basal textbook material (Ellis, 1996; Miller, 1996) and to develop effective listening and note-taking skills (Suritsky & Hughes, 1996). Students may be asked to demonstrate their knowledge and understanding of subject content by taking tests (Hughes, 1996), answering questions, constructing projects, solving math problems (Miller, 1996), and writing papers.

The tasks for cooperative learning lessons vary depending on the academic and collaborative objectives, corresponding roles and responsibilities, and the activity chosen. For instance, a lesson about whales might include (a) the objective "describe the characteristics of different types of whales"; (b) three roles: writer, reader, spokesperson; and (c) a compare-and-contrast worksheet to complete during research using an encyclopedia. The tasks would consist of fulfilling one's role responsibilities, reading and comprehending information from an

encyclopedia, comparing and contrasting information, and listening to and participating in group discussion.

Research studies on cooperative learning involving students with LD have shown great variance in the types of tasks students are required to fulfill. For example, studies have emphasized students' reading with partners (O'Connor & Jenkins, 1994), answering comprehension questions, and writing stories (Cosden et al., 1985; Slavin, Madden, & Madden, 1988). Other studies have focused on the use of computer-assisted instruction for practicing computational skills (Fuchs, Bahr, & Rieth, 1989) and the completion of individualized math assignments with group support (Slavin et al., 1984).

**Requisite Abilities.** Requisite abilities are skills required to accomplish the tasks of the setting demands (Bryant & Rivera, 1995). For instance, "reading the textbook" involves the requisite abilities of visual acuity, decoding, reading comprehension, and fluency skills. Listening to a group member requires the ability to attend and to identify the important points. For the vast majority of students, these requisite abilities are present, but for some students with learning disabilities, the skills that are necessary for meeting specific tasks are lacking and adaptations are required. Examples of setting-specific demands for cooperative learning are provided in Table 1.

## Student-Specific Characteristics

**Functional Capabilities.** Functional capabilities refer to cognitive (e.g., reading, writing, reasoning); sensory (e.g., visual, auditory); language (e.g., listening, speaking); or motor (e.g., fine, gross) strengths that individuals use to perform tasks. Functional capabilities play a crucial role in the selection of assistive technology devices—the devices must be matched to each individual's strengths or capabilities. For instance, a student who has a reading disability yet has good listening skills (i.e., functional capability) might benefit from tape-recorded text. In the same way, a student's functional capability (e.g., fine-motor skills) might dictate whether a standard keyboard, touch screen, or voice recognition software is used for inputting information into a computer.

**Functional Limitations.** Functional limitations are disability-related barriers that may limit a student's academic performance and impede his or her ability to meet the demands of the instructional setting. Functional limitations include difficulties with academic skills, motor skills, sensory abilities, memory, and organizational skills. Students with specific learning disabilities may have functional limitations (e.g., motor problems, difficulty with written expression or reading, limited computational skills) that inhibit their full participation in coop-

**TABLE 1**  
Cooperative Learning Setting-Specific Demands: Tasks and Requisite Abilities

Setting demands	Tasks	Requisite abilities
Roles	Fulfill responsibilities assigned to each role	Writing, keeping time, reading, and speaking
Groups	Work collaboratively in small groups with peers	The collaborative and interpersonal skills (e.g., accepting different viewpoints, problem solving, providing feedback, sharing) necessary for working with other people
Activities	Complete the lesson's activity, engage in discussions, contribute ideas, be responsible for learning the material	The listening, speaking, reading, writing, mathematics, and reasoning skills necessary for task completion

erative learning activities. For instance, a student who has a writing disability (e.g., dysgraphia) may not be able to serve in the "writer" role (setting demand), which involves the tasks of taking notes and writing legibly and fluently, and the requisite abilities of using a pencil, identifying main points, using an effective note-taking strategy, and knowing correct letter formations.

Teachers can address questions related to student-specific characteristics in much the same way that they answered questions pertaining to setting-specific demands (see Figure 1). Combining information from both sets of questions can assist in identifying appropriate assistive technology adaptations to meet individual student needs in cooperative learning activities.

### **Assistive Technology Adaptations**

Professionals can use information about setting-specific demands and student-specific characteristics to select assistive technology adaptations. Particular features of the AT devices must be examined to determine an appropriate match among the device, the setting-specific demands (i.e., tasks and requisite abilities), and the student-specific characteristics. In the following sections, types of adaptations, selection of assistive technology devices, and training are discussed.

**Types of Adaptations.** For students with learning disabilities, assistive technology adaptations can be identified according to the type of disability, such as reading, writing, or mathematics; adaptations can be categorized as technological and nontechnological. Adaptive devices range on a continuum from simple to complex (McGregor & Pachuski, 1996), depending on such factors as ease of implementation; technological features (e.g., hardware platform specifications, electronic capabilities); user, family, and teacher training requirements; and maintenance. For instance, a tape re-

corder might be considered a relatively simple device because (a) simply depressing a button activates it (buttons can be color-coded or numbered to facilitate correct sequencing to play a selection or record answers), (b) the technological features consist of auditory output and recording capabilities; (c) most students know how to use a tape recorder or can learn operating procedures quickly; (d) and tape recorders are fairly durable, low maintenance devices. Examples of assistive technology devices for specific learning disabilities are presented in Table 2 (and see Raskind and Higgins's article in this series for additional information about AT devices), and examples of the application of assistive technology adaptations to cooperative learning are provided in Table 3.

**Student-Technology Match.** When selecting assistive technology adaptations, technology team members must decide what type of adaptations would enhance the student's performance (Bowser & Reed, 1995). During the selection process for matching the adaptation to the student's needs, certain evaluation criteria should be considered, including (a) ease of use (setup, operation, maintenance); (b) amount of training required for the user (student) and provider (teacher, family); (c) cost (to purchase, to maintain, to repair); (d) technological features (e.g., computer modifications, specialized software programs, compatibility with other devices); (e) functional assistance (e.g., pencil grip enables some students with motor problems to grasp and hold a pencil more readily; speech synthesizer [with appropriate software] reads text shown on the monitor, thus enabling students with reading problems to access the text material); (f) performance (reliable, durable, safe); (g) use across environments and tasks; (h) promotion of student independence; and (i) user's knowledge of how to use the device (Raskind & Bryant, 1996).

Selection of an assistive technology device should be guided by the setting-specific demands, the capabilities a

person must possess to use the device, and the individual's functional limitations that will be bypassed by using the device. For instance, certain levels of reading and spelling ability may be necessary for using software adaptations. Input devices vary in design and access capability; these features must be matched appropriately to individual student needs (capabilities and limitations).

The implications of technology for the user and family are critical. Richards (1995) discussed guidelines for teams who determine appropriate student-technology matches. Families should be aware of the outcomes of assistive technology adaptations; these outcomes should reflect their needs in promoting independence for their child. Technology adaptations should enhance the child's functional capabilities and the family's abilities to meet the needs of their child. Support services, such as training and funding options, should be available to families as they adjust to the adaptations their children require as part of appropriate educational programming. Finally, team members must be sensitive to diverse family values and viewpoints about technology adaptations. Educators must consider family experience and comfort level with technology, their acceptance of instructional adaptations in general, and the resources that are necessary to help families accommodate assistive technology adaptations in their homes. Moreover, technology team members must consider the user's viewpoint and motivation when selecting assistive technology adaptations (Carney & Dix, 1992). The student's opinions about the types of adaptation options and the obtrusive nature of adaptations, attitude about using adaptations, and interest in trying available options must also be considered during the selection process.

**Training.** Assuming that classroom teachers have been adequately trained to use assistive technology adaptations, the next step is to teach



**TABLE 2**  
Examples of Assistive Technology Adaptations

Disability	Adaptations	Description
Reading	Tape-recorded material	Audio recordings of textbook material and answers to chapter or workbook questions
	Semantic mapping software	Software (e.g., Inspiration™) that enables readers to comprehend narrative story or expository writing elements through graphic depiction
	Electronic word recognition and definition	Presents definitions of words (e.g., Franklin Speaking Language Master™)
	Closed-circuit television	Magnifies reading material; limited reading presented at once
	Speech synthesizer/screen reader software	Computerized voice "reads" material on computer monitor (e.g., DecTalk™)
	Optical character recognition (OCR)/scanner	Text is scanned into computer and OCR system computerizes text so it can be "read" by speech synthesis (e.g., JAWS™)
Written expression	Pencil grip	Piece of plastic that is attached where the pencil is grasped
	Alternative-hardware input devices	"Stickie keys," touch screens, trackballs, customized keyboards
	Semantic mapping software	Software (e.g., Inspiration™) for outlining and organizing writing
	Tape recorder	Standard tape recorder for dictation of written products
	Word prediction software	Software that assists with sentence structure and syntax (e.g., Co:Writer™)
	Speech recognition	Voice recognition enabling dictation of written content (e.g., Dragon Dictate™, Kurzweil Voice™)
	Electronic spelling devices	Devices that speak and display, or only display, words and definitions (e.g., Franklin Speaking Language Master™, Franklin Spelling Master™)
	Word processing spellcheck option	Standard spellcheck option
Mathematics	Speech synthesizer/talking software	Speech synthesis with word processing program (e.g., Write:Outloud™)
	Graph paper	Centimeter squares for aligning numbers
	Calculators	Devices for checking answers; talking calculators (Radio Shack Talking Calculator™ Model EC-208); large keyed calculators
	Talking clocks	Specially designed clocks that tell time verbally
	Timing devices	Various devices for monitoring time

students how to use the devices (Raskind & Shaw, 1996; see Bryant et al. in this series for teacher preparation information). Student training should consist of components of effective teaching, including (a) providing a rationale for the device's use; (b) teaching the vocabulary related to the device; (c) giving explicit instructions (e.g., modeling, examples, feedback) in how to use the device; and (d) monitoring student use of the device to ensure proper implementation (Anderson-Inman et al., 1996; Church & Glennen, 1992).

Day and Edwards (1996) suggested several training strategies including

visual, oral, and written instructions, whereby students review videotapes and diagrams on correct implementation, and the use of adaptations is modeled. Guided practice opportunities should be available to ensure that students are learning to use adaptations correctly, and frequent comprehension checks are necessary to determine student understanding of the adaptation.

If a computer is provided, then the student's computer literacy and keyboarding skills must be assessed and developed (MacArthur, 1988; Raskind & Bryant, 1996). In particular, as Anderson-Inman et al. (1996) asserted,

students with learning disabilities would be well served by extensive instruction and practice on keyboarding skills. Fluency-building exercises could be a part of the instructional process, whereby students' keyboarding skills are timed and evaluated. Additionally, training should occur with the input device (e.g., touch-sensitive mouse, trackball mouse, touch screen); it takes time to develop the fine-motor dexterity for using various input devices.

Family members may also require training in the use of specific types of assistive technology devices (e.g., laptop computers, software) that their



**TABLE 3**  
Application of Assistive Technology Adaptations to Cooperative Learning

Adaptations	Compensatory possibility	Application
Tape recorder	Answers could be recorded	Help students serve as writers
Talking calculator with enlarged keys	Students with computational difficulties can use the calculator to check their answers; the visual display coupled with the auditory feedback provides corrective feedback; the enlarged keys could make it easier for younger students to manipulate the symbols	The materials person could use the calculator to compute the group's arithmetic
Electronic spelling devices	Students with spelling problems can use these devices to check and correct misspellings	The writer could check spelling, search for a definition, identify syllables for words, etc.
Voice recognition	Students with written communication problems and/or fine-motor problems can generate printed text	The student could serve in the role of writer by dictating into the computer's system the content generated by the group
Alternative input devices	Students with fine-motor problems can access the process of entering information into the computer	The student could be assigned the writer's responsibilities by using the computer and an alternative input device to foster keyboard/input access

*Note.* From *Teaching Students with Learning and Behavior Problems* (3rd ed.), by D. P. Rivera and D. D. Smith, 1997, Boston: Allyn & Bacon. Copyright 1997 by Allyn & Bacon. Adapted with permission.

children bring home (if recommended by the child study team) to complete homework assignments (Carney & Dix, 1992). Training procedures can be similar to those completed with the children, including instructions on handling, care, and storage of devices to promote proper treatment of expensive hardware.

### Monitoring the Use of Assistive Technology Adaptations During Cooperative Learning Activities

Monitoring the use of assistive technology adaptations during cooperative learning activities represents the second component of the process of technology integration. Although the technology team members may be available to address specific issues, it is usually the responsibility of one team member to monitor the overall use of assistive technology adaptations; the technology team should identify that person (Bowser & Reed, 1995). During the implementation phase of cooperative learning, teach-

ers (both general and special educators) usually are responsible for monitoring group interactions and students' abilities in completing the tasks; additionally, they can facilitate the integration of assistive technology adaptations into group activities by noting environmental factors and observing student use of devices/adaptations.

### Environmental Factors

An analysis of hardware and software features (e.g., sound, space, electrical specifications) may reveal the necessity of restructuring the environment to foster effective integration of devices into instruction (Church & Glennen, 1992; Raskind & Shaw, 1996). A device's sound level (if applicable) must be considered relative to other students' ability to work without distractions (Carney & Dix, 1992). Devices that produce sound (e.g., talking calculators, speech synthesizers, tape recorders, speaking spelling programs, word prediction software) may need to be used in a place in the classroom where sound distractions are minimized and devices can be used unobtrusively.

Teachers may have to consider furniture (e.g., computer and printer table) requirements to accommodate various devices. Designing environmental space and layout for additional furniture configurations may be necessary with the introduction of high-technological adaptations. These configurations should occur within the context of maintaining opportunities for students' face-to-face interactions and the ability to work collaboratively and interdependently in cooperative learning groups.

Devices that require electricity (e.g., computers, tape recorders) may necessitate that some cooperative learning groups be placed in close proximity to electrical outlets and in an area of the room where electrical cords do not impede classroom traffic patterns. Very often, the location of classroom electrical outlets dictates environmental configurations of small-group activities and furniture (Rivera & Smith, 1997). Thus, as teachers monitor cooperative learning groups, they can address environmental considerations that may impede the successful integration of assistive technology adaptations.

## Use of Assistive Technology Adaptations

Teachers can determine whether implementation of the assistive technology adaptation was successful by examining and evaluating several factors. First, they should note the ease of implementation of the technology adaptation and determine if students are using the device/adaptation properly, as taught during training. In some cases, corrective feedback, cue cards, modeling, or further training may be necessary to facilitate proper use, depending on the complexity of the technological or nontechnological adaptation. If the adaptation entails the use of a computer, basic computer literacy skills need to be assessed; they take time to develop and will affect successful use of a keyboard, word processing program, and peripherals.

Second, the performance or functioning (i.e., reliability and durability) of technological adaptations should be monitored carefully (Bowser & Reed, 1995). If problems consistently necessitate teacher intervention (e.g., to correct "error messages," replace parts, decipher speech output, correct speech recognition problems) and thus hinder student achievement, then the use of the technological or nontechnological adaptation may need reconsideration.

Third, the use of the assistive technology adaptation should be monitored in terms of the student's ability to keep pace with his or her peers to complete the cooperative learning activity. Students may need practice using various types of adaptations (technological in particular); their fluency in using adaptations may take time to develop, which would require some patience from their peers. For instance, Anderson-Inman et al. (1996) found that middle and high school students with learning disabilities expressed a need to develop fluent keyboarding skills so that they could use specialized software for studying purposes.

In this section, monitoring of environmental factors and student use of

devices were discussed as important considerations for integrating assistive technology into cooperative learning activities. Next, the integration of assistive technology devices is evaluated to determine if the goals of mastery of instructional objectives, independence, and accessibility are being achieved.

## Evaluation

Evaluation is the final component of the process of integrating assistive technology adaptations into cooperative learning activities. Technology team members must determine whether assistive technology adaptations are instructionally beneficial for students with LD. They must decide if the technology adaptations are effective in helping students (a) compensate for specific difficulties (e.g., academics), and thus (b) engage in group activities and complete role responsibilities to accomplish the goals of cooperative learning, including mastery of academic and collaborative instructional objectives. Evaluation of cooperative learning activities per se was discussed earlier in this article; the evaluation emphasis in this section is on the effectiveness of the assistive technology adaptation.

Evaluation is an ongoing process that has been discussed in terms of selection of the AT device/adaptation, training on use of the device, and implementation of the device to promote accessibility during the cooperative learning activity. Foremost, technology team members must determine if the AT adaptation is accomplishing the goal for which it was intended (Bowser & Reed, 1995), as specified on the Individualized Education Program (IEP) or the Individualized Determination Plan (IDP). Data collected on student progress pertaining to IEP or IDP goals should assist evaluators in determining the effectiveness of the adaptation in helping students reach the designated goals.

Student independence in accomplishing instructional objectives is a

desirable outcome of the AT adaptation. Students who must rely on others are at a great disadvantage in many arenas.

Teachers must also examine whether the adaptation is tapping capabilities and helping students access the setting demands of their instructional environments (e.g., cooperative learning), that is, whether the student-technology match is appropriate. Teachers can note if the device/adaptation helps the student circumvent his or her disability-related limitation, keep pace with group members, and increase success and independence. As student needs change due to evolving academic setting demands, new technology adaptations may be necessary (or, perhaps the initial technology adaptation was an inappropriate choice; Bowser & Reed, 1995). For instance, a student who uses a talking calculator to facilitate the process of calculation may still be hampered if the keys on the device are too small for someone with fine-motor difficulties. In this case, teacher evaluation might reveal that an instrument with larger keys is needed to complete the calculation task. In the area of spelling, teacher evaluation during group activities may reveal difficulties with the use of a specific spelling correction system. Although the array of correction systems holds great promise for students with spelling problems, the limitations of various systems must be examined and matched appropriately with student needs. For instance, word processing spell-check programs that are used as a proofreading device work well for students whose spelling errors can be "interpreted" (and thus a list of options can be generated for the misspelled word; Edyburn, 1992). However, teachers may find that for students with severe spelling problems, the word processing approach may not be the best choice (MacArthur, 1996). As seen in Figure 2, evaluations may reveal that a technological or nontechnological adaptation is not appropriate, and that as setting demands and student needs change, new adapta-

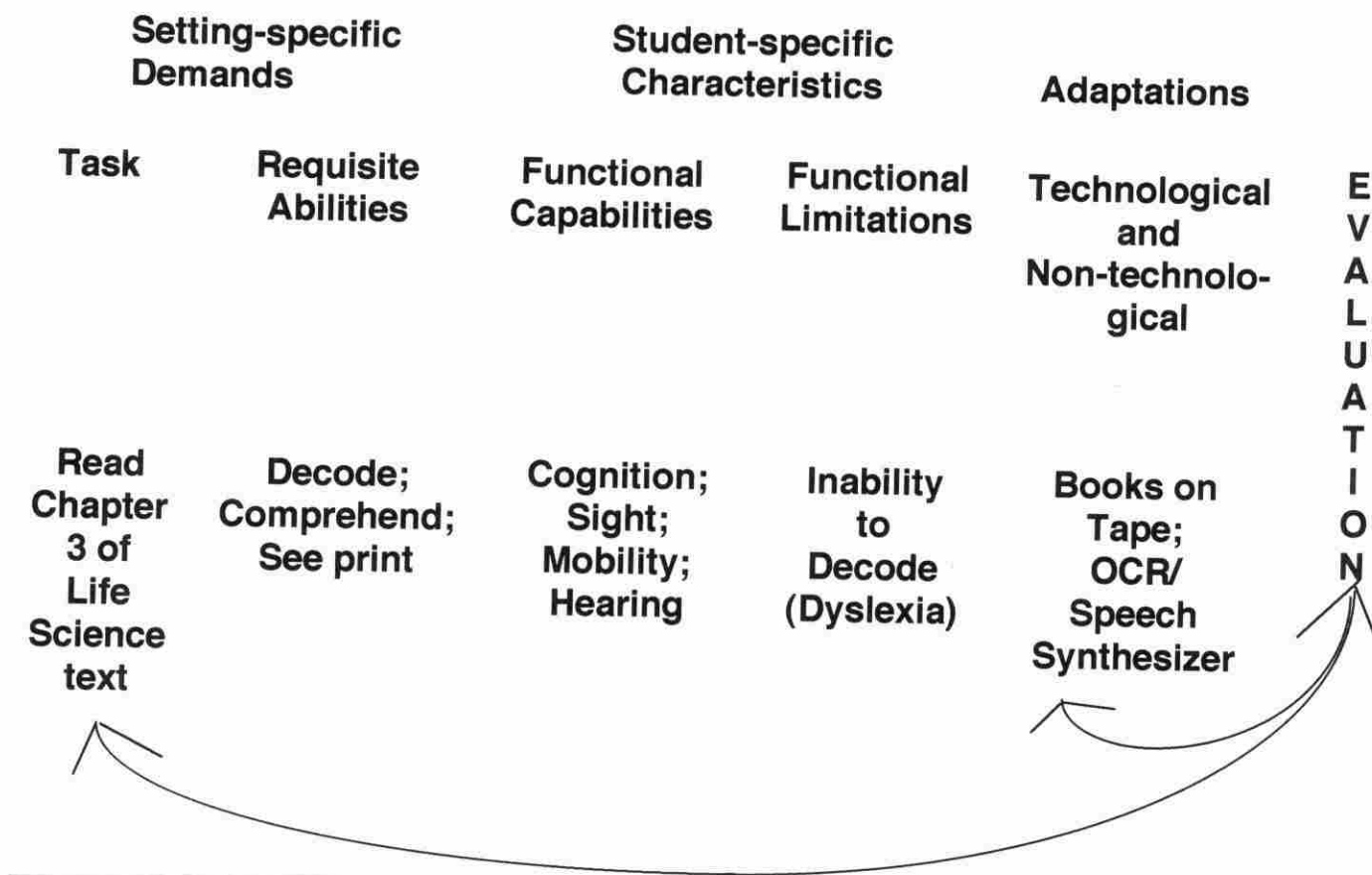


FIGURE 2. Assistive technology adaptations—problem solving and evaluation.

tions may be necessary to foster instructional success, independence, and accessibility.

### Final Thoughts

Researchers have shown that cooperative learning can be an effective instructional arrangement to teach and reinforce skills and concepts. However, for some students with learning disabilities, specific barriers to cooperative learning may necessitate instructional adaptations, including assistive technology adaptations, to promote accessibility to the activities. The purpose of this article was to discuss a process for integrating assistive technology adaptations into cooperative learning activities so that students with learning disabilities could meet the

setting-specific demands. Three components of the process were discussed, including selecting devices or adaptations, monitoring the use of the devices during cooperative learning activities, and evaluating their effectiveness.

The integration of technology adaptations is deemed highly desirable and indicative of the increasing use of technology in classrooms (Hanley, Appel, & Harris, 1988). As noted in the literature, some discussion has arisen about models for technology integration; however, additional models, principles, strategies, and research describing the integration process are needed (Edyburn, 1992). In particular, descriptions of effective integration practices from school districts are necessary—descriptions that speak to practices that overcame barriers and provided the support systems teachers need to

incorporate assistive technology adaptations into classroom instruction.

Barriers to effective integration and the support systems teacher desire have been described in the literature (Blackstone, 1990; McGregor & Pachuski, 1996). For instance, although special and general education teachers may self-rate their technology skills as "proficient," the complexity of equipment, the time required to prepare for and learn the equipment, and a lack of assistance were rated as barriers to effective use of technology (McGregor & Pachuski, 1996). Furthermore, general education teachers' desire to make instructional adaptations (including use of technology) is rated consistently higher than the feasibility of doing so (Schumm, Vaughn, Gordon, & Rothlein, 1994; Schumm, Vaughn, & Saumell, 1994). Similarly, the technology support systems that

teachers viewed as highly desirable involved time, funding for maintenance, and training in small, focused groups or one on one (McGregor & Pachuski, 1996). Even though school districts may be offering more technology inservice opportunities and colleges of education may be integrating technology into teacher preparation coursework more frequently, the issues of generalization of training to the realities of the classroom, time constraints, and training on equipment actually being used by students with disabilities remain problematic and must be addressed systematically. For instance, technology teams, inservice models (e.g., technical assistance, coaching), and collaborative partnerships between colleges of education and school district technology teams may be helpful in addressing some of the barriers identified in the literature.

The use of assistive technology adaptations by students with learning disabilities requires continued research and consideration by technology team members (Behrmann, 1994). Although recognition of the usefulness of AT adaptations in helping students with LD compensate for learning difficulties is beginning to affect the LD field (see the *Journal of Learning Disabilities*, Vol. 29, No. 4, and Vol. 29, No. 5), practitioners continue to use AT adaptations primarily with students who have other types of disabilities (e.g., physical and sensory; McGregor & Pachuski, 1996).

Finally, technology adaptations are a tool for educators to employ in providing appropriate instruction for students with learning disabilities. However, as MacArthur (1996) noted, effective instructional techniques that integrate technology must be developed wherein the principles of effective instruction are combined with technology's potential.

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